APPLICATION

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TITLE: NETWORK NODE CONFIGURATION

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NETWORK NODE CONFIGURATION

[0001] This invention relates to the configuration of a network node.

BACKGROUND

[0002] A managed network typically includes several managed nodes that are under the centralized control of a management station. Each managed node maintains configuration data that describes how that managed node is to operate. As part of its management function, the management station may need to modify this configuration data. This requires that the managed node and the management station establish communication. A suitable protocol for establishing communication between a management station and its managed nodes is SNMP (Simple Network Management Protocol).

[0003] With SNMP as the communication protocol, each managed node maintains its configuration data locally in a management information base ("MIB"). Because the management node and the management station must communicate across a network, the management station cannot directly access the MIB of a managed node. Instead, the management station sends a message to an SNMP agent executing on the managed node. The SNMP agent then operates on the MIB in response to instructions contained in that message.

[0004] To modify configuration data, a network administrator at the management station identifies the objects in the MIB that are to change. The administrator then

sends SNMP "set" requests to individually change those objects.

BRIEF DESCRIPTION OF THE FIGURES

[0005] FIG. 1 shows a managed network;

[0006] FIG.2 shows a managed node; and

[0007] FIGS. 3 and 4 are flowcharts.

DETAILED DESCRIPTION

[0008] FIG. 1 shows a managed network **10** in which a management station **12** communicates with several managed nodes **14a-d** using the common open policy protocol (COPS), and in particular, using an extension of that protocol, COPS-PR, that is specifically adapted for policy provisioning. Each managed node **14a-d** thus functions as a policy enforcement point ("PEP") and the management station **12** functions as a policy decision point ("PDP"). The managed nodes **14a-c** can be routers, bridges, hosts, printers, and similar devices.

[0009] The use of COPS-PR to communicate management data between managed nodes **14a-d** and a management station **12** enables a network administrator to specify a desired configuration at a more abstract level than that which can be specified with SNMP. In effect, COPS-PR acts as a compiler that translates the more abstract description of a desired configuration into the elementary operations supported by SNMP for operating on the MIB.

[0010] FIG. 2 shows a representative managed node **14a** in more detail. The managed node maintains a local MIB **16** that contains configuration data as well as various operating statistics. An SNMP agent **18** in communication with the local MIB **16** modifies or retrieves objects in the local MIB **16** in response to received instructions. As indicated by the arrows in FIG. 2, when the SNMP agent **18** receives a "set" instruction, it modifies an object in the local MIB **16**. When the SNMP agent **18** receives a "get" instruction, it retrieves an object from the local MIB **16**.

[0011] In a conventional network, the SNMP agent **18** receives "get" and "set" instructions from SNMP messages sent by the management station **12**. However, in the managed network **10** of FIG. 1, the management station **12** emulates a COPS PDP by sending COPS-PR messages to managed nodes. These COPS-PR messages include attached objects that specify the desired changes in the configuration. The COPS-PR messages are not understood by the SNMP agent **18**. As a result, it is necessary to provide a translator that converts a COPS-PR message into a form understood by the SNMP agent.

[0012] A COPS-PR shim layer **20** executing on the managed node **14a** provides this translation function. The shim layer **20** is configured to emulate a COPS PEP by receiving COPS-PR messages from the management station **12** and providing a corresponding sequence of calls to the API (application

program interface) of the SNMP agent **18**. The shim layer **20** is also configured to receive data extracted from the local MIB **16** by the SNMP agent **18** and to repackage that data into a corresponding COPS-PR messages for sending to the management station **12**.

[0013] Because local MIBs vary from one managed node to the next, the shim layer **20** does not know precisely which objects in the local MIB **16** are to be accessed or modified in response to a COPS-PR message from the management station **12**. For this reason, the shim layer **20** maintains communication with an auxiliary MIB **22** that stores metadata descriptive of data stored in the local MIB **16**.

[0014] The metadata stored in the auxiliary MIB **22** includes a specification of data from the local MIB **16** that is to be supplied to the management station in response to a COPS-PR "REQ" or "RPT" message and a specification of data from the local MIB **16** that is expected from the management station upon receiving a COPS-PR "DEC" message. The auxiliary MIB **22** thus functions as a dictionary available for reference by the shim layer **20**.

[0015] As an example, a managed node **14a** can be a router in which the local MIB **16** includes statistics on the number of broadcast packets that have passed through the router. These statistics are identified by an object identifier ("OID") within the local MIB **16**. Periodically, the management

station **12** may request reports from that managed node **14a**, Such a report would include a large number of statistics in addition to the particular statistic described above.

[0016] In collecting statistics from the managed node **14a**, it is more efficient to issue a single request for a report rather than to issue a sequence of requests for each individual statistic within the report. To accomplish this, the auxiliary MIB **22** includes all OIDs that identify statistics to be retrieved when the management station **12** requests a report. Upon receiving a COPS-PR communication requesting a report, the shim layer **20** searches the auxiliary MIB **22** for all OIDs associated with a request of that type. The shim layer **20** then formulates the individual calls to the API of the SNMP agent **18** to carry out the request. This enables the network management station **12** to issue what amounts to a macro instruction and to have the shim layer **29** decompose that macro instruction into its elementary parts.

[0017] The metadata in the auxiliary MIB **22** is pre-specified by a network administrator. The network administrator provides the metadata to the auxiliary MIB **22** through an SNMP session with the managed node **14a** or by using the CLI (command line interface) of the managed node **14a**. Alternatively, the network administrator can provide the metadata to the auxiliary MIB **22** remotely through a COPS-PR protocol session that uses a client type different from the

client type used for other COPS-PR traffic between the management station **12** and the managed node **14a**. On the basis of this client type, the shim layer **20** distinguishes between COPS-PR communications for accessing the auxiliary MIB **22** and COPS-PR communications for accessing the local MIB **16**. Once the auxiliary MIB **22** has been built, the shim layer **20** can then begin operation.

[0018] The auxiliary MIB **22** can also include a listing of objects in the local MIB **16** whose values are to be reported periodically to the management station **12** for accounting purposes. In this embodiment, the shim layer **20** monitors the elapsed time since the last report to the management station **12**. When the shim layer **20** determines that another accounting report is due, it formulates calls to the API of the SNMP agent **18** to retrieve the desired object values. It then packages those values in a COPS-PR message and sends that message to the management station **12**.

[0019] FIG. 3 shows the response of the shim layer to a COPS-PR communication received from the network manager. The shim layer receives **24** the COPS-PR message and obtains **26** metadata from the auxiliary MIB. This metadata enables the shim layer to identify the objects in the MIB that are to be accessed in connection with the COPS-PR message. The shim layer then formulates **28** a sequence of one or more calls to

the API of the SNMP agent. Collectively, these API calls carry out the instructions in the received COPS-PR message.

[0020] FIG. 4 summarizes the response of the shim layer to messages received from the SNMP agent. The shim layer receives **32** messages from the SNMP agent and accesses the auxiliary MIB to obtain **34** metadata. This metadata enables the shim layer to formulate **36** a COPS-PR message corresponding to the SNMP agent's messages. The shim layer then sends **38** this COPS-PR message to the network manager.

[0021] Other implementations are within the scope of the following claims: